

TECHNICAL EVALUATION OF THE SIMULATOR, FLARE SM-875A/ALE

BY JAMES R. LUEKING

JULY 1997

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13. ABSTRACT (Maximum 200 words) This report covers the Technical Evaluation of the Simulator, Flare SM-875A/ALE. The design and development of the Simulator was completed and the Technical Evaluation Test Program is hereby reported with conclusions and recommendations for production and service of this Simulator for Decoy Flares. The use of these low cost simulators should result in considerable savings to the fleet during aircraft crew training. The Technical Evaluation Test Program provides assurance of the safety and reliability of the Simulator and a recommendation for release to production. This product improvement uses more plastic parts including a biodegradable candle housing.				
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I. BACKGROUND

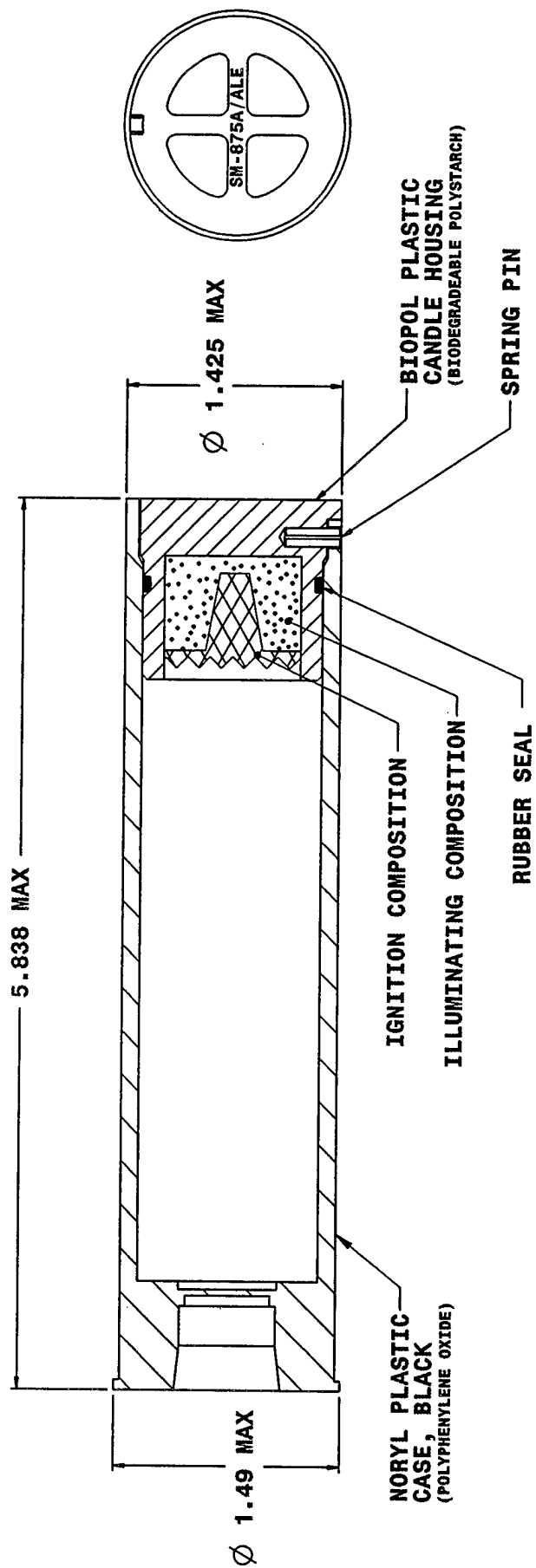
A. Intended Use. The SM-875A/ALE Simulator, Flare will provide a low cost training round which can be used to familiarize pilots and ordnance technicians with the use and handling of decoy flares. It contains a small amount of illuminating composition to produce a bright display which simulates current Navy decoy flares. It was developed as a lower cost and more environmentally friendly replacement for the SM-875/ALE Simulator. The SM-875A/ALE Simulator is identical in size to the Mk 46, MJU-8A/B, MJU-32/B, and MJU-38/B Infrared Decoy Flares and uses the same CCU-63/B Impulse Cartridge.

B. Description. The SM-875A/ALE Simulator, Flare consists of a cylindrical black plastic case approximately 5.838 inches in length and 1.42 inches in diameter. A cross-sectional view is shown in Figure 1. It weighs about 91 grams. The base end of the flare case is flanged to fit the counterbore of an AN/ALE-29A or AN/ALE-39 Countermeasures Dispensing Set. The end of the flare case opposite the flanged base is closed with the white biodegradable plastic candle housing with an O-ring seal. The design of the SM-875A/ALE is similar to the original except for more extensive use of plastic for the case and candle housing and elimination of the red lead ignition mix. Alternative flare compositions have been evaluated as both MTV and Illuminating compositions will be in the data package. Internally the SM-875A/ALE Simulator has 8 grams of pyrotechnic composition and 3 grams of ignition composition pressed to form the flare candle. The candle is ignited by the Impulse Cartridge which ejects it from the Dispenser.

C. Shipping Container. SM-875A/ALE Simulator, Flares are packaged 80 to a M548 Shipping Container in accordance with Drawing 3176AS200. Palletizing is in accordance with MIL-STD-1323-368.

D. Explosive Hazard Classification. The SM-875/ALE has a Shipping classification of Signal Flares, Class C Explosive. The Storage classification is 1.4 G. The Net Explosive Weight is 11 grams (.024 lb) per Simulator. The SM-875A/ALE classification has been applied for and is expected to be the same as the SM-875/ALE. The SM-875A/ALE has been assigned the NSN 1370-01-447-2580 and a NALC code of LA10.

E. Handling Instructions. All loading, downloading, and other handling of the SM-875A/ALE shall be in accordance with the applicable Loading Manual for the Aircraft. All procedures pertaining to the use and maintenance of the Dispenser Sets, including information on loading and downloading these Simulators, are contained in NAVAIR 16-30ALE29-3 and NAVAIR 16-30ALE39-1. Technical Manual, NAVAIR 11-15-7, Pyrotechnic, Screening, Marking, and Countermeasure Devices contains additional descriptive and handling information and Safety Precautions. The SM-875A/ALE Simulator is a training device to be used in place of Mk 46 Mod 1C and MJU-8A/B flares presently in widespread fleet use and can be safely handled and stored in the same manner. No testing or maintenance will be required at the fleet level. No special Equipment is required for handling operations.



SM-875A/ALE FLARE SIMULATOR

FIGURE 1

II. TECHNICAL EVALUATION PLAN.

A. Test Plan Two hundred twenty SM-875A/ALE Simulators, Flare were subjected to the tests as outlined by the Technical Evaluation Plan (Figure 2). The purpose of these tests was to establish the safety and suitability of the design and to establish test and performance baselines. Test categories included Hazard Assessment, Durability, and Functional testing. The SM-875A/ALE Simulator utilizes conventional pyrotechnic compositions for producing a visible display. The Testing of the SM-875A/ALE Simulator followed procedures in Mil-Std-2105, Mil-Std-810, OES-3023, Mil-Std-331, or others as referenced and the Testing SOP. In addition to these tests reported herein, Long term Storage simulation at elevated temperatures will be conducted to determine Shelf Life for the SM-875A/ALE.

B. Add-On Tests A Mid-test design modification discussed in paragraph III.A.1.b. resulted in a parallel sample of 12 simulators for the Safety Series and replacement of the 60 Flight Test simulators with the improved design. The change was considered minor with no effect on function but improvement in sealing. The change is illustrated in Figure 3.

TECHNICAL EVALUATION
FLARE, SIMULATOR-SM875/ALE
PRODUCT IMPROVEMENTS
220 FLARES

NSWCCR/RDTR-97/21

CATAPULT LAUNCH
ARRESTED LANDING
TESTING

X-RAY
LEAK TEST

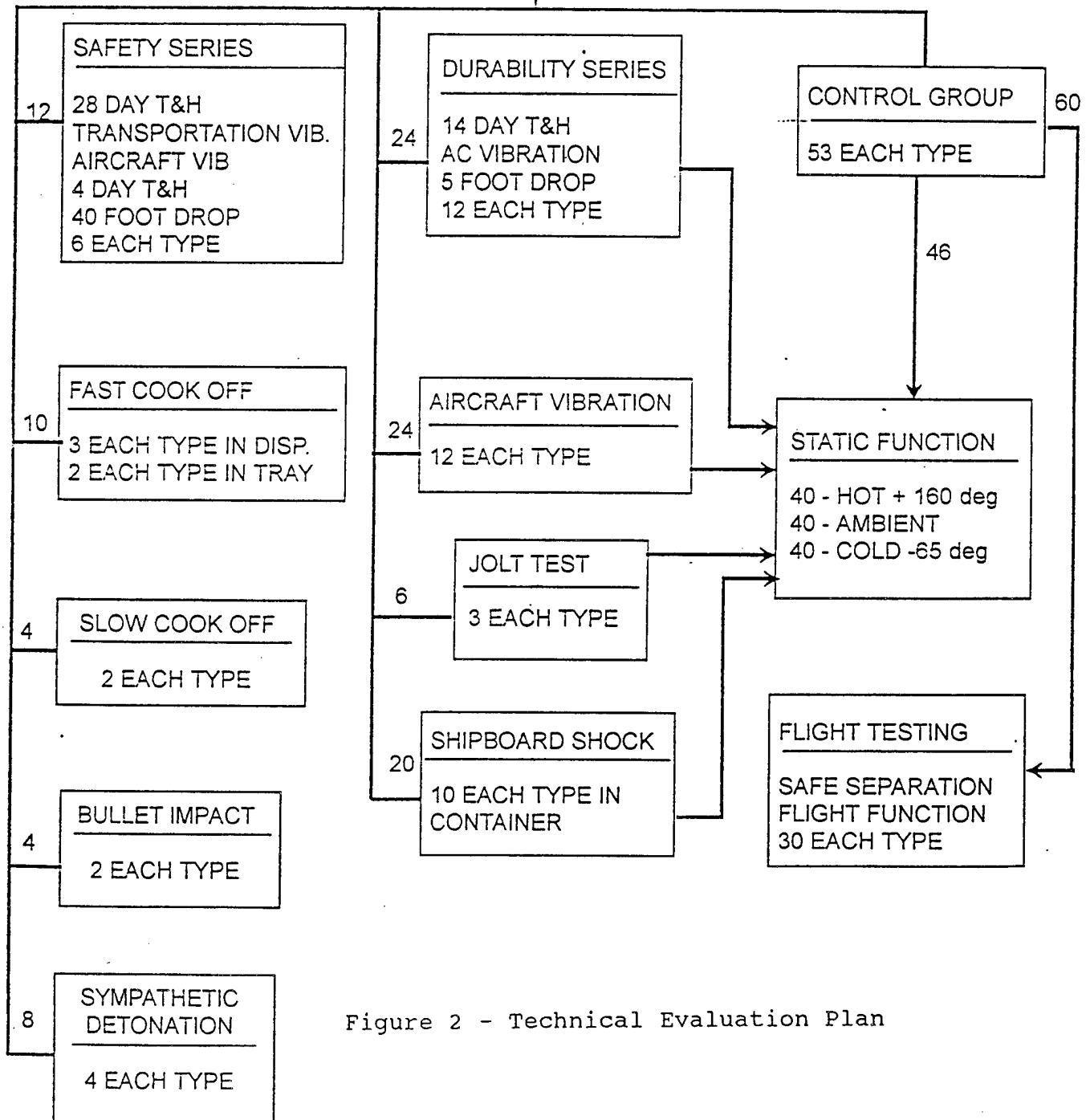


Figure 2 - Technical Evaluation Plan

III. TEST RESULTS

Test and Conditioning results were reported individually by the Evaluation Engineer to the Development Engineer and Branch Supervision as the tests were completed. The individual test reports for Functional Testing are in appendix A of NSWCCR/RDTR-97/21 in greater detail for reference and all tests have been summarized in this section. All flares were examined, leak tested, and x-rayed at the start of the Test Program. No anomalies were found in the initial visual examination.

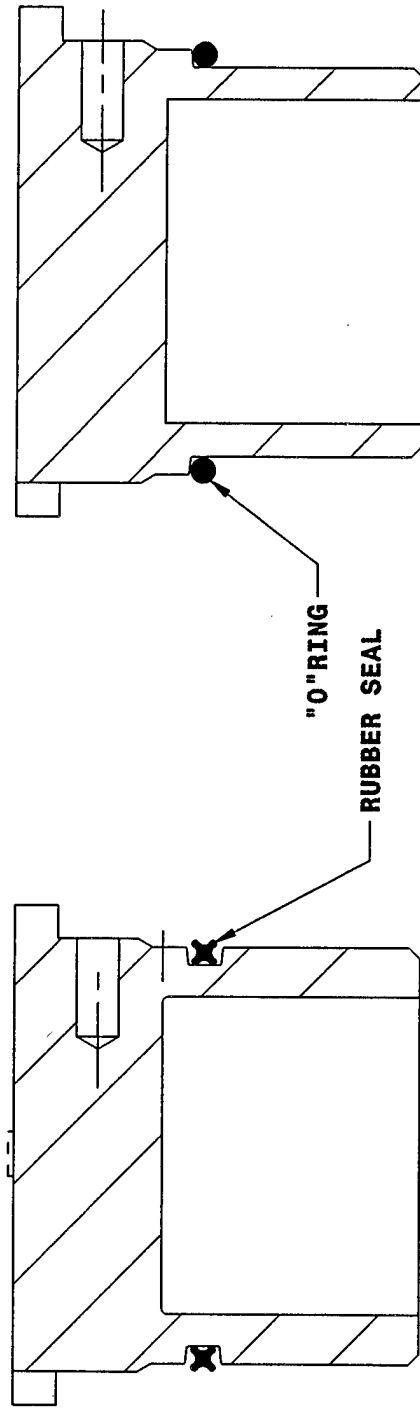
A. Hazard Assessment. Thirty-eight of the SM-875A/ALE Simulators were scheduled for the safety testing as shown in the Technical Evaluation Plan.

1. Safety Series.

a. 28 Day Temperature & Humidity Cycling. The simulators for the Technical Evaluation after Temperature and Humidity cycling (both 14 and 28 day) were examined by Code 4052, Environmental Test Branch, prior to loading into the Aircraft Vibration fixture. Concerns were raised by the test operator about the internal pressure buildup which raised the end cap up on one side opposite the single assembly pin. The cap could be pushed down with finger pressure but would pop back up. The pressure was seen on both leakers and non-leakers. This condition was not considered a fatal safety or functional failure when noted earlier by Code 4071, Countermeasures Development Branch. After discussion with Code 0671 (Occupational Safety), the Design Engineer replaced the simulator cases and eliminated the internal pressure allowing Techeval vibration to continue. These were leak tested by 40511, Ordnance Test Branch prior to returning them to 4052 for vibration with no leakers found after case replacement in 36 flares.

b. Design Modification. After the pressurization was noted in November, the Design Engineer made and tested two design improvements to keep the cap from popping up. An extended candle case and a second assembly pin were both satisfactory after T&H in keeping the cap from popping up and leaking. The pressurization of magnesium compositions was considered unavoidable and not a safety or functional problem for Simulators. Twenty-five simulators of each type were conditioned and static functioned satisfactorily. The extended candle case (see Figure 3) was the preferred improvement. A separate sample with the extended candle case will be subjected to the Safety Series and the flight test sample for Techeval will be replaced also. The remaining simulators of the original design will continue in the test sequences to avoid considerable delay and expense in completion of the Technical Evaluation.

c. Transportation Vibration. The Leak Test of SM-875A/ALE Simulators for the Technical Evaluation after Vibration was completed on 14 January 1997 by Code 40511. Twelve simulators were tested and one leaker was found. No anomalies were found and the Simulators have passed Transportation Vibration conditioning.



ORIGINAL DESIGN

IMPROVED DESIGN

**CANDLE HOUSING,
BIOPOL PLASTIC
(BIODEGRADABLE POLYSTARCH)**

FIGURE 3

d. Aircraft Vibration. The Aircraft Vibration of SM-875A/ALE Simulators for the Technical Evaluation Safety Series was completed on 22 January 1997 by Code 4052. Twelve simulators were tested and no defects were found after conditioning. The Aircraft Vibration of Simulators for the Durability Series was also completed by Code 4052. Twenty-four simulators were tested and no defects were found. The Leak Tests of SM-875A/ALE Simulators after Aircraft Vibration of the Durability Series and Safety Series was completed on 23 January 1997 by Code 40511. Thirty six simulators were tested and no leakers were found.

e. 4 Day T&H. The Safety Series Simulators were satisfactory after 4 Day T&H with no anomalies.

f. 40 Foot Drop Test. The 40 Foot Drop Tests of SM-875A/ALE Simulators Safety Series was completed on 30 January 1997 by Code 40511. The lightweight plastic cases withstood the impacts with little noticeable marking. The SM-875A/ALE Simulators have sequentially met the passing criteria for 28 Day T&H, Transportation Vibration, Aircraft Vibration, 4 Day T&H, and 40 Foot Drop. The SM-875A/ALE Simulators therefore have met the passing criteria for the Safety Series from Mil-Std-2105B.

2. Safety Series with Design Modification After the internal pressurization was noted in earlier T&H tests, the Design Engineer made and tested two design improvements to keep the Candle Housing from popping up. An extended Candle Housing and a second assembly pin were both satisfactory after T&H in keeping the cap from popping up and leaking. Twenty-five simulators of each type were conditioned and both types static functioned satisfactorily. The extended Candle Housing was the preferred improvement. A separate sample of twelve Simulators with the extended Candle Housing has been subjected to the Safety Series of this Technical Evaluation. This report section covers those tests.

a. Six simulators with IR composition and six with Illuminating composition with the improved Candle Housing completed 28 Day T&H on 27 February 1997 with no defects. Leak testing of these showed no leaks also.

b. These same 12 simulators completed Transportation Vibration on 26 March 1997 with no defects. X-rays and leak testing after vibration also showed no anomalies or leakers.

c. After considerable delay due to facility changes, these same 12 simulators completed Aircraft Vibration on 11 June 1997 with no defects. X-rays and leak testing after vibration also showed no anomalies or leakers.

d. Four Day T&H was completed on 27 June 1997 with no defects also. Leak testing and X-rays also had no anomalies.

e. The Forty Foot Drop Tests of twelve SM-875A/ALE Simulators after the Safety Series was completed on 15 July 1997 by Code 40511. The lightweight plastic cases withstood the impacts with very little noticeable marking. Table 1 reports the results by simulator. The plastic case rebounded on impact and appeared to have no permanent deformation. However the case often cracked around the assembly pin and two Candle Housings separated from the case on impact. Since the Simulator has no internal igniter, this is not considered a safety problem, the components were not unsafe to handle. The flare composition remained inside the Candle Housing. The simulators could have been loaded into the dispenser block and fired after the drop test. The SM-875A/ALE Simulators with the Candle Housing improvement have therefore passed the Safety Series of testing.

TABLE 1 - SM-875A/ALE SIMULATORS TECHEVAL
DROP TEST RESULTS

SM-875	ORIENTATION	RESULTS	CONCLUSION
TYPE II SIMULATORS - ILLUMINATING COMP.			
1	CANDLE HOUSING DOWN	SLIGHT SCUFF ON END	SATIS-FACTORY
2	BASE DOWN	SCUFF ON IMPACT EDGES	"
3	HORIZONTAL	CASE CRACKS AT PIN	"
4	45 DEG. CANDLE DOWN	CASE CRACKS AT PIN	"
5	45 DEG. BASE DOWN	CANDLE HOUSING SEPARATED FROM CASE, COMPOSITION REMAINED IN HOUSING	"
6	CANDLE HOUSING DOWN	SLIGHT SCUFF ON END	"
TYPE I SIMULATORS - IR COMPOSITION			
1	CANDLE HOUSING DOWN	SLIGHT SCUFF ON END	SATIS-FACTORY
2	BASE DOWN	SLIGHT SCUFF ON HOUSING END, TURNED OVER IN AIR	"
3	HORIZONTAL	CANDLE HOUSING SEPARATED FROM CASE, COMPOSITION REMAINED IN HOUSING	"
4	45 DEG. CANDLE DOWN	SOME CRACKS AT PIN	"
5	45 DEG. BASE DOWN	SCUFFED ON HOUSING END, CRACK AT PIN	"
6	CANDLE HOUSING DOWN	SLIGHT SCUFF ON HOUSING, CASE CRACK AT PIN	"

3. Fast Cook-off in Dispenser. The Fast Cook-off Testing of six SM-875A/ALE Simulators in a D-27 Dispenser Block inside a AN/ALE-29/39 Dispenser was completed 10 April 1997. The flares in the Simulators (both compositions) in the dispenser block cooked-off at approximately 2 minutes and 20 seconds into the test. The fuel fire melted the aluminum dispenser housing and allowed the molten metal to fall into the fuel pan. All empty tubes in the block were filled with insulation material to block the heat transfer within the block. The plastic outer cases of the items were protected enough by the block so that they did not melt and fall into the pan. Three of the burned off candle housings and two o'rings were found in the fuel pan. Video coverage recorded the magnesium composition burning in the fuel fire. Photographs were taken of the test setup, the residue after the test, and the block residue after the test and are in Appendix B.

4. Fast Cook-off of Bare Flare. Four bare SM-875A/ALE Simulators were also tested on 8 April 1997 in a mesh tray above the fuel fire. These reacted in 2 minutes and 30 seconds but the reaction was again just rapid burning of the pyrotechnic composition. The recorded temperatures ranged from 1500 to 2000 degrees Fahrenheit for the entire test. A flash of the brighter magnesium composition fire was seen in the video of the fuel fire. The test residue included only the fiber filler of the plastic cartridge retainer ends of the cases found in the tray. These Type V reactions of the SM-875A/ALE Simulators met the passing Criteria in MIL-STD-2105B.

5. Slow Cook-off (Type I). The Slow Cook-off Test of one SM-875A/ALE Simulator was completed on 14 February by Code 40511 at the Ordnance Test Area. This was a Type I Simulator with the Magnesium/Teflon/Viton (MTV) composition also used in Decoy flares. The Simulator flare cooked-off at approximately 978 degrees Fahrenheit. The reaction was no more than Level V or rapid burning. This reaction was in the same temperature range as the MJU-32, MJU-36, and MJU-38 Decoy Flares with the MTV composition. Test residue was photographed as was the oven set up. The oven was not damaged and will be used again for the second test. Most of the residue was the 20% fiberglass filling of the Noryl plastic (Polyphenylene Oxide) used for the flare case. Some ash or carbon-like residue was found on the floor of the oven beneath the suspended case residue. The flare was MTV composition and the candle housing was a molded plastic (Biodegradable Poly-starch) composition. The Melting point of the candle housing material was 304 degrees Fahrenheit while the deflection temperature for the case material was 290 degrees Fahrenheit. Video coverage recorded no audible expulsion or ignition but only some smoky reaction of the flare and possibly the oven insulation walls. This Level V reaction meets the passing Criteria in Mil-Std-2105B.

6. Slow Cook-off (Type II). The second Slow Cook-off Test of the SM-875A/ALE Simulator was completed on 28 February by Code 40511 at the Ordnance Test Area. This was a Type II Simulator with

the Magnesium/Sodium Nitrate flare composition and Magnesium/Teflon/ Viton (MTV) ignition composition. The Simulator flare cooked-off at approximately 911 degrees Fahrenheit. The reaction was no more than Level V or rapid burning. This reaction was slightly less than the 978 degrees of the Type II MTV composition of the first test. The oven was not damaged and may be used again. Most of the residue was the 20% fiberglass filling of the Noryl plastic used for the flare case. The flare had Magnesium/Sodium Nitrate flare composition and MTV ignition composition. The candle housing was the same as reported above. This test was interrupted when it appeared to reach equilibrium at 760 degrees. The oven temperature failed to rise even when the input was increased to 100%. The oven was shut off and allowed to cool. The insulation walls were removed and the material was examined but not handled. The Flare outer case (Noryl) had melted and the residue was hanging on the suspension rod of the oven. The candle housing (Biodegradable Poly-starch) had fallen out of the case and decomposed or evaporated. The pressed candle composition was intact and laying under the case as was the metal assembly pin. The Thermocouples were bent to a position directly over the flare composition pellet to pickup any reaction and the oven reassembled with an additional layer of insulation. The test was restarted with the oven controller at 100% output. The composition subsequently underwent a burning reaction at approximately 911 degrees Fahrenheit. Video coverage recorded a slight popping ignition sound and some flame and smoke from the flare reaction exiting one corner of the oven insulation. This Level V reaction meets the passing Criteria in Mil-Std-2105B.

7. Bullet Impact. The Bullet Impact test for the SM-875A/ALE Techeval was done on 4 March 97 at the Ordnance Test Area at NSWC Crane. Two Simulators of each type composition were impacted by 50 caliber AP projectiles at a velocity of approximately 2800 fps.. The tests were targeted on the flare grain. Three projectiles were fired with approximately 50 millisecond intervals for each test but not all impacted the small targeted flare section. Still photographs were taken of the test setup and the flare residue. High speed video recorded the flare reaction to projectile impact. Projectile velocity was measured and reaction overpressure was measured at 30 and 45 feet from the impact point.

TABLE 2 - Bullet Impact Results

TARGET	AVERAGE VELOCITY (ft/sec)	PRESSURE 30ft/45ft (psi)	TEST RESULTS
SM-875A/ALE FLARE TYPE I #179	2656	.049psi/ .017psi	Projectile hit 14 gram flare section and ignited it. Plastic outer case fractured and was found within 10 feet of impact area. Separated flare fragments burned and were not found.
SM-875A/ALE FLARE TYPE I #180	2651	none meas.	Projectile hit grain and ignited it. No reaction more severe than burning. Similar to first test.
SM-875A/ALE FLARE TYPE II #8	2682	none meas.	Four bursts were fired at Simulator without hitting flare section. Plastic case was pierced and later broken until flare candle housing fell out. Unable to hit flare.
SM-875A/ALE FLARE TYPE II #9	2714	none meas.	Three bursts were fired at simulator until plastic case and candle housing broke. Unable to hit small 14 gram flare section.

The video recording, recovered test residue, and witness board behind the test Simulator all indicated that there was no reaction greater than rapid burning of the flare grain. These results correspond with other Bullet Impact tests of decoy flares with similar grain compositions. Accordingly the SM-875A/ALE Simulator has passed the Bullet Impact test of Mil-Std-2105B. Since the Simulator is used for Aircraft training, it is unlikely that it would ever be exposed to bullet impact as in a combat zone.

8. Sympathetic Detonation. The Sympathetic Detonation Test of SM-875A/ALE Simulators for the Technical Evaluation was completed on 10 February 1997 by Code 40511. Simulator Unit # 1 (donor) was initiated by a 3/4 inch diameter C4 charge with an electric blasting cap while taped to Unit # 2 (acceptor). The charge was placed directly above the candle housings except for test 4. For test 4 the charge was above the middle of the case of the donor. The detonating charge ruptured both plastic cases on all tests and ignited the donor flare grain for tests 1, 2, and 3 and possibly the acceptor flare grain on 2 and 3. The acceptor flare was found separated from its holder on the first test but was not found on tests 2 and 3. Visible burning of composition for 4

seconds was seen at the base of the post on tests 2 and 3. On the fourth test both flare grains were found on the ground not ignited. Results in the tests are summarized in Table 3 below.

TABLE 3 - Sympathetic Detonation Results

TEST	SIMULATOR, NUMBER		RESULTS
TYPE I - MAG/TEFLON/VITON COMP			
1	SM-875	1 D	CASE BROKEN BY CHARGE, GRAIN NOT FOUND
	SM-875	2 A	CASE BROKEN, GRAIN FOUND INTACT BUT OUT OF CANDLE HOUSING
2	SM-875	3 D	CASE BROKEN BY CHARGE, GRAIN NOT FOUND BUT 4 SEC BURN SEEN AT POST
	SM-875	7 A	CASE BROKEN BY CHARGE, GRAIN NOT FOUND MAY HAVE BEEN BURNED ALSO
TYPE II - MAG/SODIUM NITRATE COMP			
3	SM-875	175 D	CASE BROKEN BY CHARGE, GRAIN NOT FOUND BUT 4 SEC BURN SEEN AT POST
	SM-875	176 A	CASE BROKEN BY CHARGE, GRAIN NOT FOUND MAY HAVE BEEN BURNED ALSO
4	SM-875	177 D	CASE BROKEN BY CHARGE, GRAIN INTACT IN CANDLE HOUSING ON GROUND BY POST
	SM-875	178 A	CASE BROKEN BY CHARGE, GRAIN INTACT IN CANDLE HOUSING ON GROUND BY POST
D = DONOR, A = ACCEPTOR			

Since no Type I reaction (detonation) occurred in any donor or acceptor, the SM-875 Simulators with both types of composition have passed this hazard assessment test. This test was videotaped and test residue photographed for reference.

B. DURABILITY TESTING

1. Durability Series.

a. 14 Day T&H The Leak Tests of simulators for the Technical Evaluation after Temperature and Humidity cycling was completed on 14 November 1996 by Code 40511. Twenty four simulators were tested after 14 day T&H and nine leakers (38%) were found. The leakers all leaked at the only seal, the end cap o'ring.

b. AC Vibration. The Aircraft Vibration of SM-875A/ALE

Simulators for the Technical Evaluation Safety Series was completed on 22 January 1997 by Code 4052. Twelve simulators were tested and no defects were found after conditioning. The Aircraft Vibration of Simulators for the Durability Series was also completed by Code 4052. Twenty-four simulators were tested and no defects were found.

c. Five Foot Drop. The Five Foot Drop Tests of SM-875A/ALE Simulators after Aircraft Vibration of the Durability Series was completed on 30 January 1997 by Code 40511. The lightweight plastic cases withstood the impacts with very little noticeable marking. Table 4 reports the results by simulator as well as leak test results after drop. These recased simulator flares continued in the sequence plan for function tests.

TABLE 4 - SM-875A/ALE SIMULATORS TECHEVAL
DROP TEST AND LEAK TEST RESULTS

SM-875	ORIENTATION	RESULTS	LEAK TEST
TYPE I SIMULATORS			
11	ENDCAP DOWN	NO DAMAGE SEEN	SATIS- FACTORY
12	"	NO DAMAGE SEEN	"
13	"	NO DAMAGE SEEN	"
14	HORIZONTAL	NO DAMAGE SEEN	"
15	"	NO DAMAGE SEEN	"
16	"	NO DAMAGE SEEN	"
17	ENDCAP DOWN 45 DEG.	SLIGHT SCUFF	"
18	"	SLIGHT SCUFF	"
19	BASE DOWN 45 DEG	NO DAMAGE SEEN	"
20	"	SLIGHT SCUFF ON BASE	"
21	BASE DOWN	NO DAMAGE SEEN	"
22	"	NO DAMAGE SEEN	"
TYPE II SIMULATORS			
131	ENDCAP DOWN	NO DAMAGE SEEN	SATIS- FACTORY
132	"	NO DAMAGE SEEN	"
133	"	NO DAMAGE SEEN	"
134	HORIZONTAL	NO DAMAGE SEEN	"
145	"	NO DAMAGE SEEN	"
146	"	VERY SLIGHT SCUFF	"
147	ENDCAP DOWN 45 DEG.	SLIGHT SCUFF	"
148	"	VERY SLIGHT SCUFF ON CAP EDGE	"
149	BASE DOWN 45 DEG.	VERY SLIGHT SCUFF ON CAP EDGE	"
150	"	NO DAMAGE SEEN	"
151	BASE DOWN	SLIGHT SCUFF ON BASE	"
152	"	SLIGHT SCUFF ON BASE	"

2. Aircraft Vibration. The Leak Tests of SM-875A/ALE Simulators for the Technical Evaluation after Aircraft Vibration was completed on 31 October 1996 by Code 40511. The flares had no anomalies after AC vibration. Twenty four simulators were tested and no leakers were found.

3. Jolt. The Jolt Test of SM-875A/ALE Simulators for the Technical Evaluation was completed on 22 January 1997 by Code 4052. Six simulators were tested and no defects were found after the conditioning.

4. Shipboard Shock. The Shipboard Shock Testing of twenty SM-875A/ALE Simulators in the M548 container was completed 27 April 1997 in the Environmental Test Building 3285. The SM-875A/ALE Simulators were not damaged and the container showed no damage from the impacts. All Simulators were expended in static tests and performed satisfactorily. No effects on burn time or ignition were noted. These simulators were leak tested after the Shipboard Shock and no leakers were found. The seals were not affected by the impacts also. The SM-875A/ALE Simulators met the passing Criteria of MIL-STD-901D, Grade A, Class I requirements for lightweight equipment at ambient conditions. Grade A items shall withstand shock tests without unacceptable effect upon performance and without creating a hazard.

5. Sealing Tests. Sealing or Leak Test reports have been reported individually with conditioning since the tests are correlated. A summary of these results have been included here to show any relationship with conditioning. The following Table shows some initial problems induced by pressurization due to T&H conditioning. This problem was remedied by a minor design change shown in Figure 3 as demonstrated in the test results at the bottom of Table 5.

TABLE 5 - SM-875A/ALE SEALING TEST SUMMARY

FLARE NUMBERS	SEALING TEST RESULTS AFTER - (LEAKERS/TOTAL)				
	INITIAL	T & H CYCLE	VIBRATION	SHIPBOARD SHOCK OR T&H	OTHER TEST
11-22, 131-134, 145-152	0/24	9/24	0/24		5FT DROP
					0/24
23-28, 153-158	0/12	3/12	0/12 0/12	0/12	
29-40, 159-170	0/24		0/24		
43-52, 183,184, 215-222	0/20			0/20	
4-6, 171-173	0/6				JOLT
					0/6
OTHERS, CONTROLS	6/193				
TOTALS	6/279	12/36	0/72	0/32	0/30
	SPECIAL SAFETY SERIES AFTER DESIGN MODIFICATION				
1-6 IR, 1-6 IL	0/12	0/12	0/12 0/12	0/12	

C. FUNCTIONAL TESTING

1. Static Function. The Static Function Test of the SM-875A/ALE Simulator was completed on May 1, 1997 by Code 40511 at the Ordnance Test Area. All Simulators with both Type I and II compositions performed satisfactorily. All functional testing for this Technical Evaluation was completed using the CCU-63/B Impulse Cartridge, NSN 1377-01-082-4175 NALC MF29. Table 6 summarizes the average ejection velocities and burn times by type of conditioning and function temperature.

TABLE 6 - VELOCITY AND BURN TIME AVERAGES FOR STATIC FUNCTION
SIMULATOR SM-875A/ALE TECHEVAL - 4/30-5/1/97

CONDITIONING	TEMP	AVERAGE VELOCITY (FT/SEC)		AVERAGE BURN TIME (SECONDS)		NUMBER OF FLARES I/II
		I	II	I	II	
CONTROLS	AMBIENT	164.6	169	-	-	10/10
	-65	163.3	153.3	4.30	4.05	7/7
	+160	176	169.4	3.89	3.66	7/7
AC VIBRATION	AMBIENT	163.2	163.7	4.24	3.73	4/4
	-65	172	164	5.01	3.89	4/4
	+160	183.5	158.7	4.28	3.56	4/4
DURABILITY SERIES	AMBIENT	179.5	167.5	4.55	3.87	4/4
	-65	161	156	4.62	4.14	4/4
	+160	170.8	171.2	4.14	4.08	4/4
JOLT	AMBIENT	175	153	-	-	4/4
SAFETY SERIES	AMBIENT	167.7	182.7	4.45	3.84	6/6
SHIPBOARD SHOCK	-65	156.6	149.6	4.23	3.89	5/5
	+160	168.2	177.6	4.34	3.80	5/5
ALL COLD	-65	162.9	155.1	4.49	4.00	20/20
ALL HOT	+160	174.5	169.7	4.13	3.76	20/20
ALL AMBIENT	AMBIENT	168.7	168.7	4.42	3.82	28/28
ALL DEVICES	ALL	168.7	165.0	4.34	3.86	68/68

A review of the results in Table 6 has led to these conclusions:

A. Conditioning of the SM-875A/ALE Simulators (AC Vibration, Durability Series, Jolt, Shipboard Shock, Safety Series) had no adverse effect on function as measured by ejection velocity and burn time.

B. Ejection velocities are about 12 to 14 feet/second faster at +160 relative to -65 degrees but all are satisfactory.

C. Burn times are slightly faster (.5 second) for Type II composition but this may be varied by composition adjustment.

D. Burn times are slightly faster (.24 to .36 second) for both type compositions when functioned at +160 relative to -65 degrees.

E. The SM-875A/ALE Simulators were 100% reliable as all 68 flares ejected, ignited, and burned in the Static Function Test.

2. Flight Testing. The Flight Test of SM-875A/ALE Simulators for the Technical Evaluation was completed on 17 April 1997 by Pt.Mugu personnel using an F4D Aircraft from Tracor Flight Systems at the Mojave test range. SM-875A/ALE Simulators with MTV or MgNaNo3 composition were tested with the original design SM-875/ALE Simulators. Fifteen flares of each type were dispensed at one second intervals, three during each aircraft pass. The second half of the test was five flares at 1/2 second intervals on each pass. Four observers and cameras were stationed at both 1.5 and 3 mile sites from the drop area. All SM-875A/ALE Simulators for the Flight Test had the design modification to the Candle Housing to improve sealing. Results in the tests are summarized in Table 7.

TABLE 7 - Flight Test Results

PASS	SIMULATOR	AIRSPEED/ ALTITUDE	RESULTS
ORIGINAL DESIGN - MAG SODIUM NITRATE COMP			
1	SM-875	310 KIAS/ 1500 AGL	3 FLARES SATISFACTORY
2	SM-875	310/1500	3 FLARES SATISFACTORY
3	SM-875	310/1500	3 FLARES SATISFACTORY
4	SM-875	310/1500	3 FLARES SATISFACTORY
5	SM-875	310/1500	3 FLARES SATISFACTORY
TYPE I - MAG/TEFLON/VITON COMP			
6	SM-875A	310/1500	3 FLARES SATISFACTORY
7	SM-875A	310/1500	3 FLARES SATISFACTORY
8	SM-875A	310/1500	3 FLARES SATISFACTORY
9	SM-875A	310/1500	3 FLARES SATISFACTORY
10	SM-875A	310/1500	3 FLARES SATISFACTORY
TYPE II - MAG SODIUM NITRATE COMP			
11	SM-875A	310/1500	3 FLARES SATISFACTORY
12	SM-875A	310/1500	3 FLARES SATISFACTORY
13	SM-875A	310/1500	3 FLARES SATISFACTORY
14	SM-875A	310/1500	3 FLARES SATISFACTORY

PASS	SIMULATOR	AIRSPEED/ ALTITUDE	RESULTS
15	SM-875A	310/1500	3 FLARES SATISFACTORY
ORIGINAL DESIGN - MAG SODIUM NITRATE COMP			
16	SM-875	310/1500	5 FLARES SATISFACTORY
17	SM-875	310/1500	5 FLARES SATISFACTORY
18	SM-875	310/1500	5 FLARES SATISFACTORY
TYPE I - MAG/TEFLON/VITON COMP			
19	SM-875A	310/1500	5 FLARES SATISFACTORY
20	SM-875A	310/1500	5 FLARES SATISFACTORY
21	SM-875A	310/1500	5 FLARES SATISFACTORY
TYPE II - MAG SODIUM NITRATE COMP			
22	SM-875A	310/1500	5 FLARES SATISFACTORY
23	SM-875A	450/1500	5 FLARES SATISFACTORY
24	SM-875A	455/1500	5 FLARES SATISFACTORY
SPECIAL DEVICES			
25	MJU-27A/B	450/1500	5 DEVICES SATISFACTORY
26	MJU-27A/B	310/1700	5 DEVICES SATISFACTORY
27	OPTICAL CHAFF	310/1900	5 DEVICES SATISFACTORY

This test was videotaped from cameras at the observation sites and aboard the aircraft for reference. The videotape from the 1.5 mile site was not satisfactory due to tracking problems and visibility. The four observers at both sites noted that the MTV composition was not nearly as bright as the other compositions and that the newer SM-875A flares ignited much closer to the aircraft. Since all flares functioned satisfactorily, the SM-875A/ALE Simulators with both types of composition have passed this test.

IV. CONCLUSIONS

A. Hazard Assessment.

1. Safety Series. The SM-875A/ALE Simulator demonstrated design safety in the sequential satisfactory completion of 28 Day T&H, Transportation Vibration, Aircraft Vibration, 4 Day T&H, and 40 Foot Drop.

a. 28 Day T&H The SM-875A/ALE Simulator passed this test but internal pressure resulted in a midtest design Modification to the Candle Housing with its O'ring seal.

b. Transportation Vibration The Simulator passed this test.

c. Aircraft Vibration The Simulator passed this test.

d. 4 Day T&H The Simulator passed this test.

e. 40 Foot Drop The Simulator passed this test as the plastic case absorbed the impact with little damage.

2. Safety Series with Design Modification. The SM-875A/ALE Simulator with the improved Candle Housing demonstrated design safety in the sequential satisfactory completion of 28 Day T&H, Transportation Vibration, Aircraft Vibration, 4 Day T&H, and 40 Foot Drop. No leakers were found after any conditioning.

3. Fast Cook-off. The SM-875A/ALE Simulator passed Fast Cook-off since no reaction other than rapid burning was observed during testing of bare flares and flares in the dispenser block.

4. Slow Cook-off Both compositions met the passing criteria for this test as little reaction (rapid burning) was observed at 978 degrees Fahrenheit for Type I (MTV) and 911 degrees for Type II (Illuminating).

5. Bullet Impact The Simulator with both compositions passed this test since there was no reaction greater than rapid burning of the flare grain.

6. Sympathetic Detonation Since no Type I (MIL-STD-2105B) reaction (detonation) occurred in any donor or acceptor, the SM-875 Simulators with both types of composition have passed this hazard assessment test.

B. Durability Testing

1. Durability Series.

a. 14 Day T&H Twenty four simulators were tested after 14 day T&H and nine leakers (38%) were found. The leakers all leaked at the only seal, the end cap o'ring.

b. Aircraft Vibration. Twenty-four simulators were tested and no defects were found.

c. Five Foot Drop. The lightweight plastic cases withstood the impacts with very little noticeable marking. All functioned satisfactorily in the Static Function Test.

2. Aircraft Vibration. Twenty-four simulators were tested and no defects were found. These simulators all functioned satisfactorily in the Static Function Test.

3. Jolt. Six simulators were jolted and no defects were found. X-rays and examination revealed no defects. These simulators all functioned satisfactorily in the Static Function Test.

4. Shipboard Shock. Twenty Simulators were not damaged and the M548 Shipping Container showed no damage from the impacts. All Simulators were expended in static tests and performed satisfactorily.

C. Functional Tests.

1. Static Function.

A. Conditioning of the SM-875A/ALE Simulators (Aircraft Vibration, Durability Series, Jolt, Shipboard Shock, Safety Series) had no adverse effect on function as measured by ejection velocity and burn time.

B. Ejection velocities are about 12 to 14 feet/second faster at +160 relative to -65 degrees but all are satisfactory.

(1) Simulators with Type I composition had an average ejection velocity of 168.7 feet per second at ambient temperatures.

(2) Simulators with Type II composition had an average ejection velocity of 168.7 feet per second at ambient temperatures.

C. Burn times are slightly shorter (.6 second) for Type II composition but this may be varied by composition adjustment.

(1) Simulators with Type I composition had an average burn time of 4.42 seconds at ambient temperatures.

(2) Simulators with Type II composition had an average burn time of 3.82 seconds at ambient temperatures.

D. Burn times are slightly shorter (.24 to .36 second) for both type compositions when functioned at +160 relative to -65 degrees.

E. The SM-875A/ALE Simulators were 100% reliable as all 68 flares ejected, ignited, and burned in the Static Function Test.

2. Flight Function.

a. Reliability. The SM-875A/ALE Simulators were 100% reliable as all 30 flares of Type I and all 30 flares of Type II ejected, ignited, and burned in the Flight Function Test.

b. Observations.

(1.) Display. The SM-875A/ALE Simulators were readily visible to four observers at both the 1.5 and 3 mile sites at the Mojave Test Range. The SM-875/ALE (original design) was also visible in this same test but was not subjectively noted as either more or less bright than the Type II flares.

(2.) Separation. The newer SM-875A/ALE Simulators Types I and II both ignited much closer to the aircraft. This would benefit observers in other aircraft in picking up the display during training exercises.

(3.) Comparison. Both the Type II and the original SM-875/ALE Simulator flares were subjectively noted as brighter than the Type I (MTV) flares.

V. RECOMMENDATION

A. On the basis of demonstrated reliability and safety, the SM-875A/ALE Simulator, Flare as qualified by this Technical Evaluation shall be released to production.

APPENDIX A - TEST REPORTS

A-2 STATIC FUNCTION TEST REPORT

A-5 FLIGHT TEST REPORT

Memorandum Test Report

548A/4071
June 2, 1997

SM-875A/ALE SIMULATOR, FLARE TECHEVAL

1. The Static Function Test of the SM-875A/ALE Simulator was completed on May 1, 1997 by Code 40511 at the Ordnance Test Area. All Simulators with both Type I and II compositions performed satisfactorily. Table 1 contains the individual test results. Table 2 summarizes the average ejection velocities and burn times by type of conditioning and function temperature.

TABLE 1 - STATIC FUNCTION RESULTS

FLARE#	TEST#	CONDITIONING/ TEMPERATURE	BURN TIME	EJECTION VELOCITY
491	11	CONTROL/AMBIENT	-	91
492	12	"	2.55	91
493	13	"	-	86
494	14	"	2.43	83
495	15	"	-	100
496	16	"	2.33	91
466	17	AIRCRAFT VIB./ AMBIENT	-	111
467	18	"	-	91
468	19	"	2.46	100
469	20	"	2.44	83
470	21	"	-	83
471	22	"	2.45	91
472	23	"	2.53	77
473	24	"	2.50	91
474	25	"	2.52	105
475	26	"	2.39	118
484	57	CONTROL/ -65	2.96	91
485	58	"	2.64	95
486	7	"	2.90	100
487	8	"	2.56	83
488	9	"	2.47	83

FLARE#	TEST#	CONDITIONING/ TEMPERATURE	BURN TIME	EJECTION VELOCITY
489	10	"	2.40	91
490	11	"	2.35	80
456	12	T&H/ -65	2.46	95
426	13	DURABILITY SERIES/ -65	2.51	91
427	27	"	2.81	74
428	28	"	2.91	78
429	29	"	2.59	74
457	30	T&H/ -65	2.29	83
458	31	"	2.61	87
459	32	"	2.61	83
460	33	"	2.16	91
497	18	CONTROL/ +160	2.47	111
498	19	"	-	125
499	20	"	2.36	111
500	21	"	2.33	95
501	22	"	2.29	100
502	23	"	2.47	125
503	24	"	2.35	118
504	25	"	-	130
430	36	DURABILITY SERIES/ +160	2.58	111
431	37	"	2.51	100
432	38	"	2.44	91
461	39	T&H/ +160	2.54	118
462	40	"	2.51	111
463	41	"	-	111
464	42	"	2.65	100
465	43	"	2.38	130

TABLE 2 - VELOCITY AND BURN TIME AVERAGES FOR STATIC FUNCTION
SIMULATOR SM-875A/ALE TECHEVAL - 4/30-5/1/97

CONDITIONING	TEMP	AVERAGE VELOCITY (FT/SEC)		AVERAGE BURN TIME (SECONDS)		NUMBER OF FLARES I/II
		I	II	I	II	
CONTROLS	AMBIENT	164.6	169	-	-	10/10
	-65	163.3	153.3	4.30	4.05	7/7
	+160	176	169.4	3.89	3.66	7/7
AC VIBRATION	AMBIENT	163.2	163.7	4.24	3.73	4/4
	-65	172	164	5.01	3.89	4/4
	+160	183.5	158.7	4.28	3.56	4/4
DURABILITY SERIES	AMBIENT	179.5	167.5	4.55	3.87	4/4
	-65	161	156	4.62	4.14	4/4
	+160	170.8	171.2	4.14	4.08	4/4
JOLT	AMBIENT	175	153	-	-	4/4
SAFETY SERIES	AMBIENT	167.7	182.7	4.45	3.84	6/6
SHIPBOARD SHOCK	-65	156.6	149.6	4.23	3.89	5/5
	+160	168.2	177.6	4.34	3.80	5/5
ALL COLD	-65	162.9	155.1	4.49	4.00	20/20
ALL HOT	+160	174.5	169.7	4.13	3.76	20/20
ALL AMBIENT	AMBIENT	168.7	168.7	4.42	3.82	28/28
ALL DEVICES	ALL	168.7	165.0	4.34	3.86	68/68

Memorandum Test Report

April 17, 1997

SM-875A/ALE SIMULATOR TECHEVAL FLIGHT TEST

1. The Flight Test of SM-875A/ALE Simulators for the Technical Evaluation was completed on 17 April 1997 by Pt.Mugu personnel using an F4D Aircraft from Tracor Flight Systems at the Mojave test range. SM-875A/ALE Simulators with MTV or MagNaNo3 composition were tested with the original design SM-875/ALE Simulators. Fifteen flares of each type were dispensed at one second intervals three during each aircraft pass. The second half of the test was five flares at 1/2 second intervals each pass. Four observers and cameras were stationed at both 1.5 and 3 mile sites from the drop area. Results in the tests are summarized in Table 1 below.

TABLE 1 - Flight Test Results

PASS	SIMULATOR	AIRSPEED/ ALTITUDE	RESULTS
ORIGINAL DESIGN - MAG SODIUM NITRATE COMP			
1	SM-875	310 KIAS/ 1500 AGL	3 FLARES SATISFACTORY
2	SM-875	310/1500	3 FLARES SATISFACTORY
3	SM-875	310/1500	3 FLARES SATISFACTORY
4	SM-875	310/1500	3 FLARES SATISFACTORY
5	SM-875	310/1500	3 FLARES SATISFACTORY
TYPE I - MAG/TEFLON/VITON COMP			
6	SM-875A	310/1500	3 FLARES SATISFACTORY
7	SM-875A	310/1500	3 FLARES SATISFACTORY
8	SM-875A	310/1500	3 FLARES SATISFACTORY
9	SM-875A	310/1500	3 FLARES SATISFACTORY
10	SM-875A	310/1500	3 FLARES SATISFACTORY
TYPE II - MAG SODIUM NITRATE COMP			
11	SM-875A	310/1500	3 FLARES SATISFACTORY
12	SM-875A	310/1500	3 FLARES SATISFACTORY
13	SM-875A	310/1500	3 FLARES SATISFACTORY
14	SM-875A	310/1500	3 FLARES SATISFACTORY
15	SM-875A	310/1500	3 FLARES SATISFACTORY

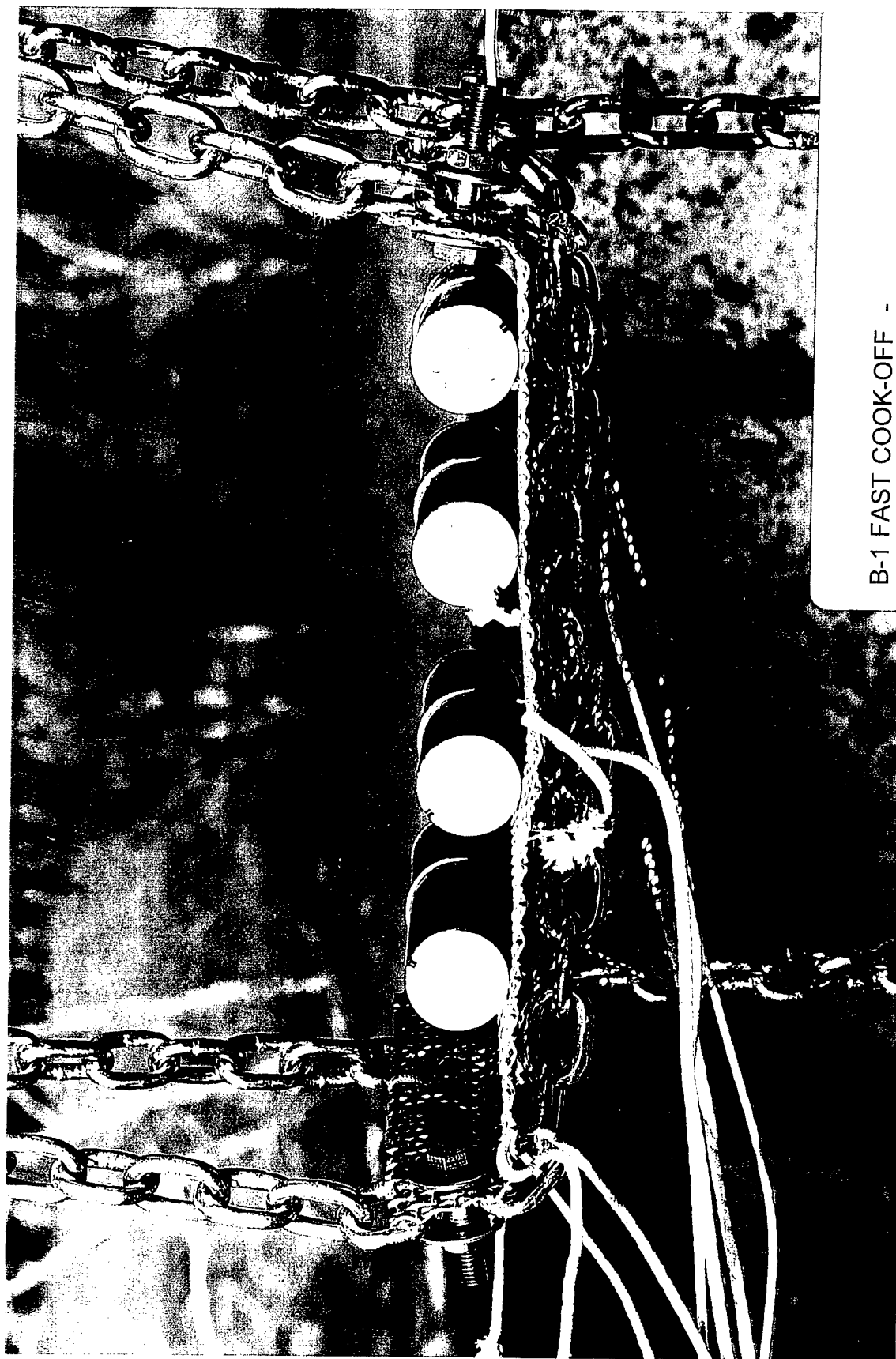
PASS	SIMULATOR	AIRSPEED/ ALTITUDE	RESULTS
ORIGINAL DESIGN - MAG SODIUM NITRATE COMP			
16	SM-875	310/1500	5 FLARES SATISFACTORY
17	SM-875	310/1500	5 FLARES SATISFACTORY
18	SM-875	310/1500	5 FLARES SATISFACTORY
TYPE I - MAG/TEFLON/VITON COMP			
19	SM-875A	310/1500	5 FLARES SATISFACTORY
20	SM-875A	310/1500	5 FLARES SATISFACTORY
21	SM-875A	310/1500	5 FLARES SATISFACTORY
TYPE II - MAG SODIUM NITRATE COMP			
22	SM-875A	310/1500	5 FLARES SATISFACTORY
23	SM-875A	450/1500	5 FLARES SATISFACTORY
24	SM-875A	455/1500	5 FLARES SATISFACTORY
SPECIAL DEVICES			
25	MJU-27A/B	450/1500	5 DEVICES SATISFACTORY
26	MJU-27A/B	310/1700	5 DEVICES SATISFACTORY
27	OPTICAL CHAFF	310/1900	5 DEVICES SATISFACTORY

2. This test was videotaped from cameras at the observation sites and aboard the aircraft for reference. The videotape from the 1.5 mile site was not satisfactory due to tracking problems and visibility. The four observers at both sites noted that the MTV composition was not nearly as bright as the other compositions and that the newer SM-875A flares ignited much closer to the aircraft. Since all flares functioned satisfactorily, the SM-875A/ALE Simulators with both types of composition have passed this test.

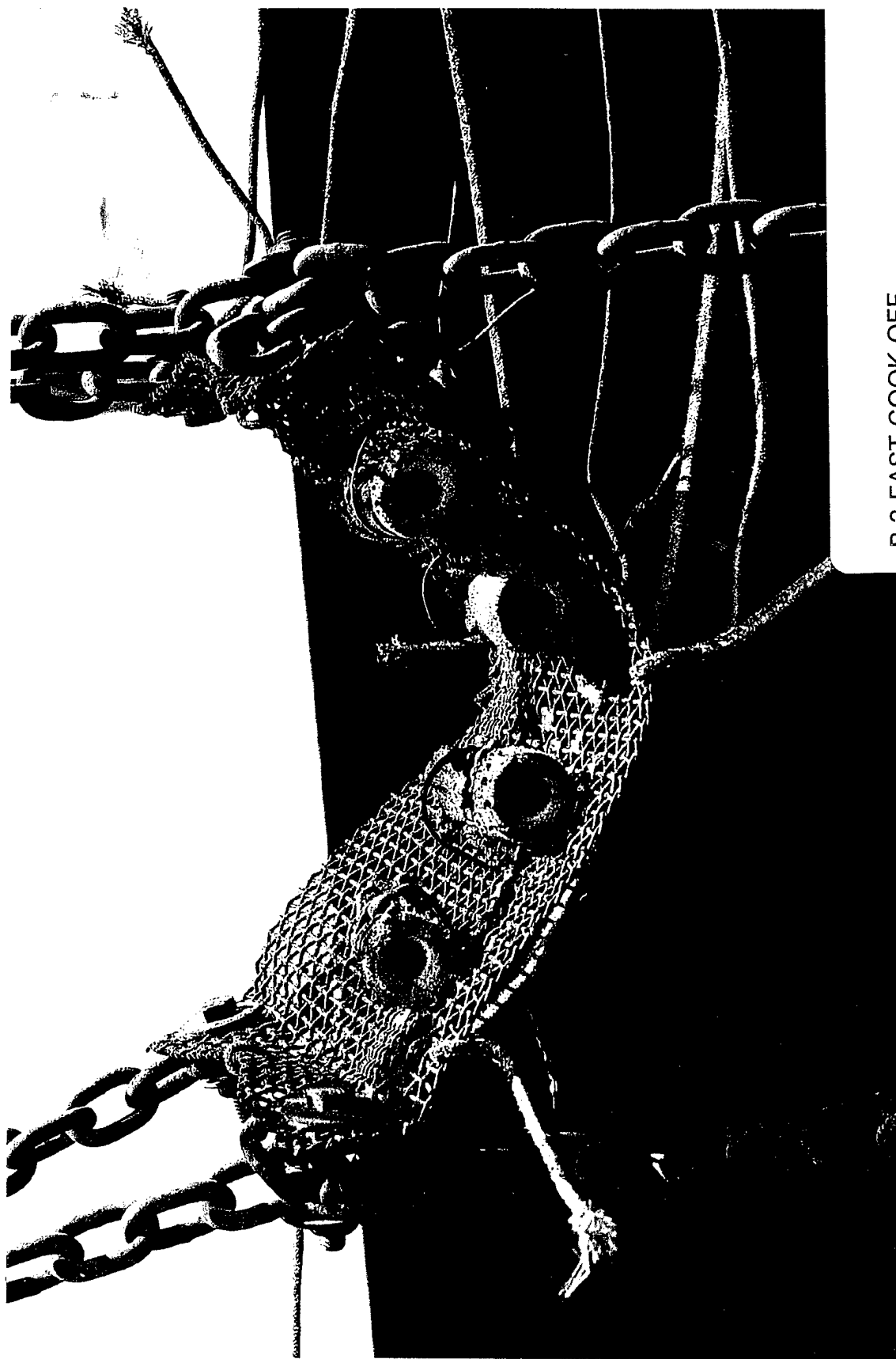
3. Prior to the Simulator flight, a Checkout Flight for the ALARMS Pod was completed with the F4D Aircraft. The Pod functioned satisfactorily launching four flares or devices each pass. Sequentially dispensed were 4 MJU-8A/B, 4 MK 46, 4 MJU-27/B, 4 MJU-8A/B, 4 MK 46, and 4 MJU-27/B. All were dispensed at 275 kias at 1500 or 1700 feet AGL. Pt. Mugu personnel were satisfied with the ALARMS Pod performance. Flares were observed at the range by Jim Lueking and Don Lagrange of the Countermeasures Development Branch, Code 4071.

APPENDIX B - TEST PHOTOGRAPHS

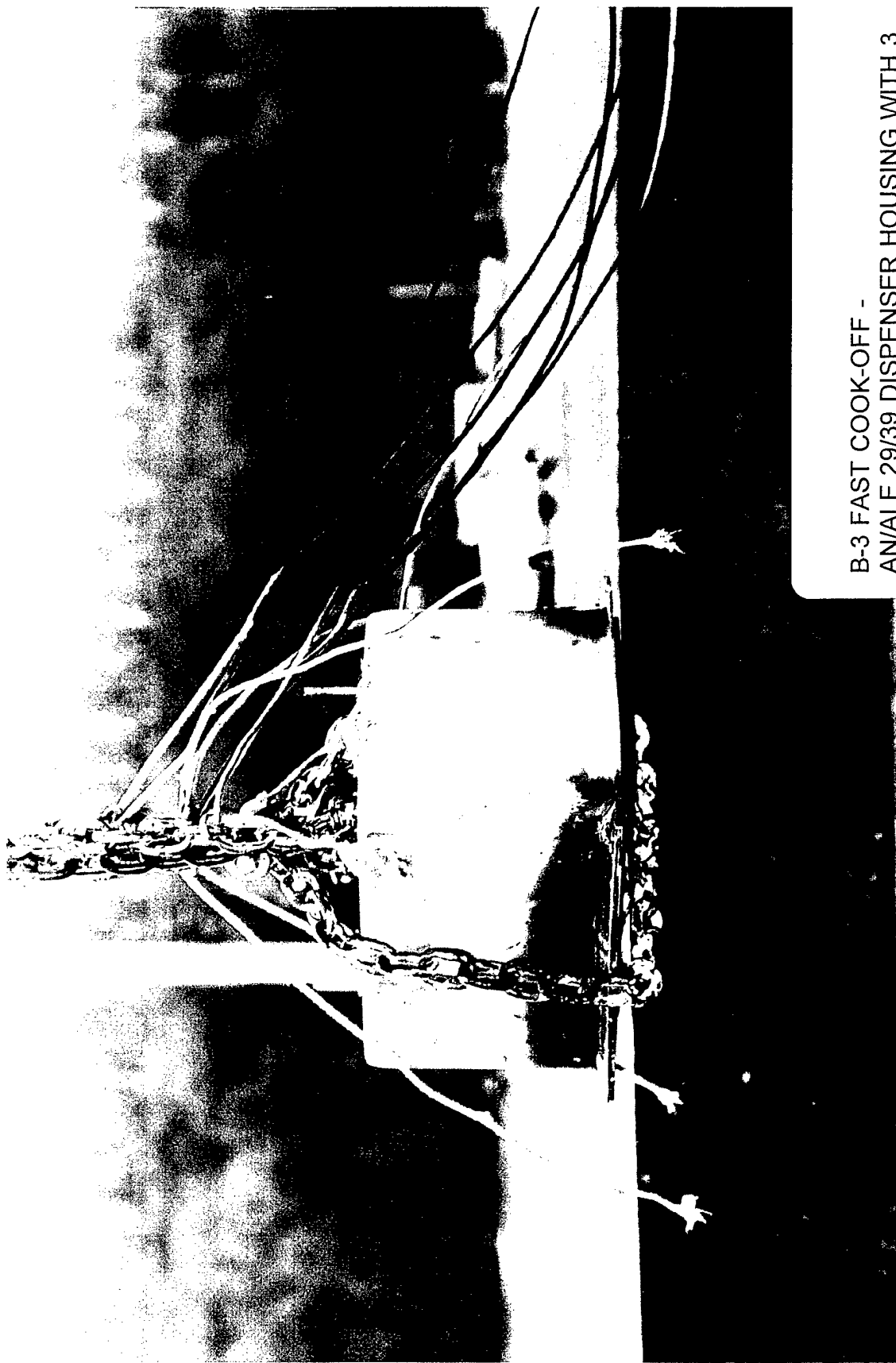
- B-1 FAST COOK-OFF - SM-875A/ALE SIMULATORS ON MESH TRAY ABOVE JP-4 FUEL PAN
- B-2 FAST COOK-OFF - SIMULATOR RESIDUE ON TRAY AFTER COOK-OFF
- B-3 FAST COOK-OFF - AN/ALE-29/39 DISPENSER HOUSING WITH THREE SIMULATORS ABOVE FUEL PAN
- B-4 FAST COOK-OFF - AN/ALE-29/39 DISPENSER BLOCK AFTER HOUSING MELTED AWAY, SIMULATOR RESIDUE STILL INSIDE TUBES
- B-5 FAST COOK-OFF - SIMULATOR RESIDUE FROM FUEL PAN AFTER TEST - O'RINGS, 3 BURNT OUT CANDLE HOUSINGS, MELTED ALUMINUM FROM DISPENSER
- B-6 SLOW COOK-OFF - INSULATED OVEN AFTER SIMULATOR COOK-OFF - NO APPARENT REACTION IMPACT
- B-7 SLOW COOK-OFF - SIMULATOR CASE RESIDUE AFTER TEST, THERMOCOUPLE WIRES AROUND CASE, REACTION RESIDUE ON FLOOR OF OVEN
- B-8 SYMPATHETIC DETONATION - BEFORE TEST SETUP OF DETONATOR, C4 COMPOSITION BALL, DONOR AND ACCEPTOR SIMULATORS - C4 IS OVER FLARE SECTION OF SIMULATOR
- B-9 SYMPATHETIC DETONATION - SIMULATOR RESIDUE AFTER TEST, DONOR FLARE IGNITED, ACCEPTOR FLARE DID NOT IGNITE, PLASTIC CASE BROKEN BY DETONATION
- B-10 BULLET IMPACT - SIMULATOR RESIDUE AFTER TESTS, TWO FLARES IGNITED BY IMPACT, TWO DID NOT
- B-11 BULLET IMPACT - TYPICAL SIMULATOR TAPED TO TARGET BOARD
- B-12 BULLET IMPACT - CANDLE HOUSING SEPARATED FROM PLASTIC CASE BUT DID NOT IGNITE



B-1 FAST COOK-OFF -
SM-875A/ALE SIMULATORS ON MESH TRAY
ABOVE JP-4 FUEL PAN



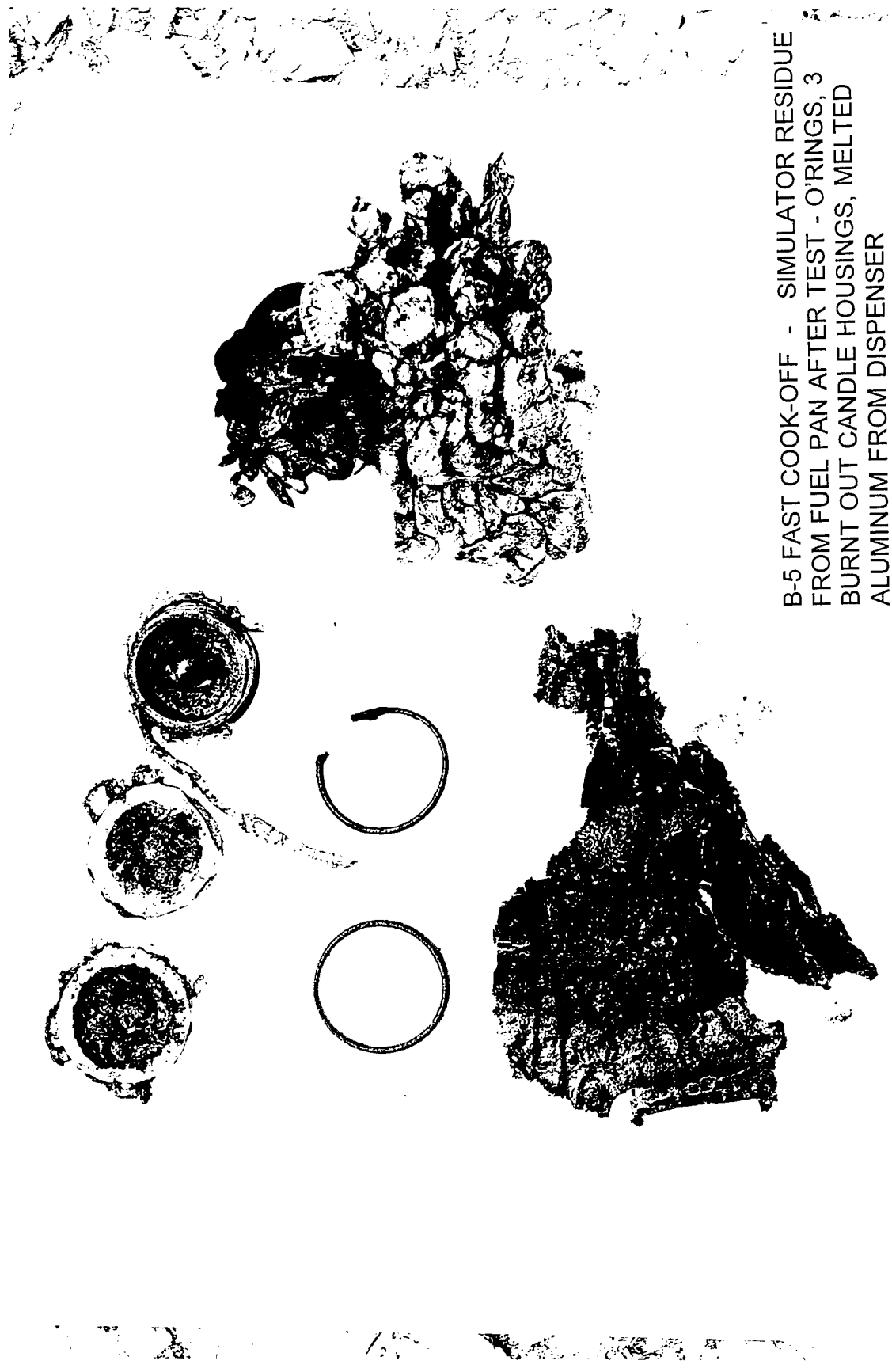
B-2 FAST COOK-OFF -
SIMULATOR RESIDUE ON TRAY AFTER
COOK-OFF



B-3 FAST COOK-OFF -
AN/ALE 29/39 DISPENSER HOUSING WITH 3
SIMULATORS ABOVE FUEL PAN



B-4 FAST COOK-OFF -
AN/ALE 29/39 DISPENSER BLOCK AFTER
HOUSING MELTED AWAY, SIMULATOR
RESIDUE STILL INSIDE BLOCK TUBES



B-5 FAST COOK-OFF - SIMULATOR RESIDUE
FROM FUEL PAN AFTER TEST - O'RINGS, 3
BURNT OUT CANDLE HOUSINGS, MELTED
ALUMINUM FROM DISPENSER



B-6 SLOW COOK-OFF -
INSULATED OVEN AFTER SIMULATOR
COOK-OFF - NO APPARENT REACTION IMPACT



B-7 SLOW COOK-OFF -
SIMULATOR CASE RESIDUE AFTER TEST,
THERMOCOUPLE WIRE AROUND CASE AND
REACTION RESIDUE ON FLOOR OF OVEN



B-8 SYMPATHETIC DETONATION -
BEFORE TEST SET-UP OF DETONATOR, C4
COMPOSITION BALL, DONOR SIMULATOR AND
ACCEPTOR SIMULATOR, C4 IS OVER FLARE
SECTION OF SIMULATOR



B-9 SYMPATHETIC DETONATION -
SIMULATOR RESIDUE AFTER TEST, DONOR
FLARE IGNITED, ACCEPTER FLARE DID NOT
IGNITE, PLASTIC BROKEN BY DETONATION



B-10 BULLET IMPACT -
SIMULATOR RESIDUE AFTER TESTS, TWO
FLARES IGNITED BY IMPACT, TWO DID NOT



B-11 BULLET IMPACT -
TYPICAL SIMULATOR TAPED TO TARGET
BOARD



B-12 BULLET IMPACT -
CANDLE HOUSING SEPARATED FROM PLASTIC
CASE BUT DID NOT IGNITE

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